lecture 7

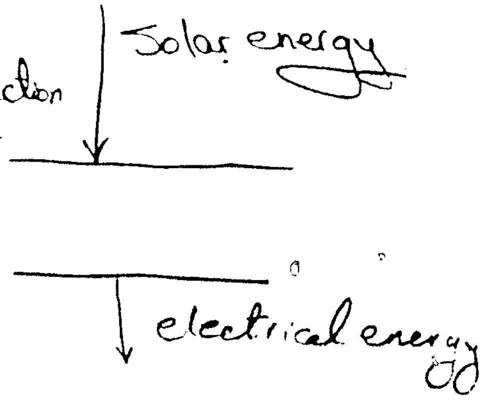
6/4/2008

* Black & Gray body are conceptential bodies.

Photovoltaic Cells :-

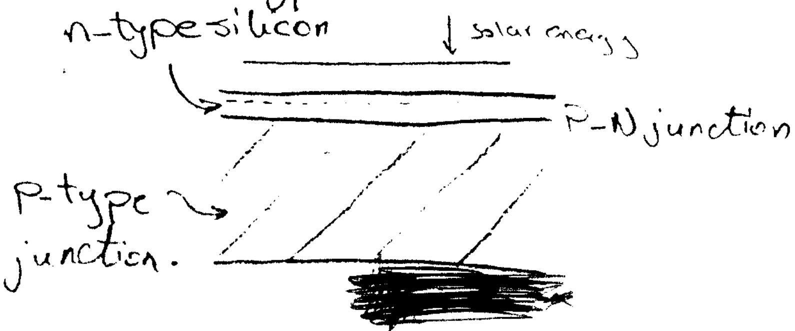
→ ~~fuel cell~~

Photovoltaic cells is P-N junction using :- P-type semiconductor
N- " " "

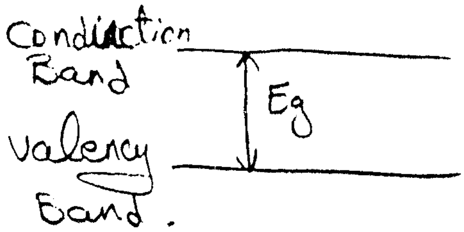


most common used :-

silicon type cells.



Any e's exist in the valency band & when solar energy fall on it then e's will move to the conductor band.



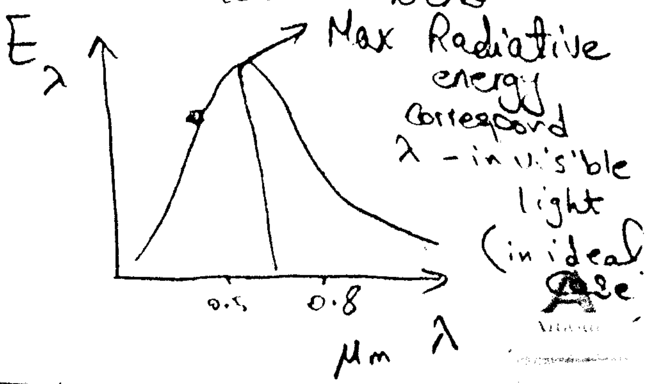
E_λ → Radiative Energy.
↳ Energy flux per unit wavelength.

→ Energy of photon $E = h\nu$, $\nu\lambda = c$

→ Not all typs of photons have sufficient energy to make the e's move to the conduction band.

Note :-

the integration of $\int_0^\infty E_\lambda \, d\lambda$ is equal to $E = \sigma T^4$

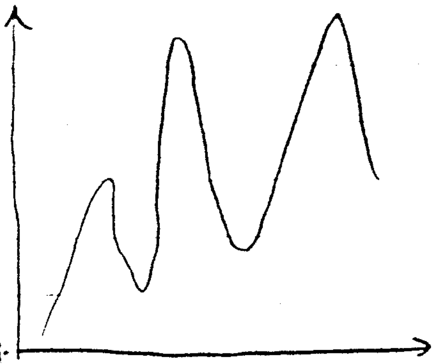


Due to the presence of more than one absorpance band (e.g CO_2, Ozone) so the Radiations that reach earth surface is not uniform.

→ max. photon conversion eff.

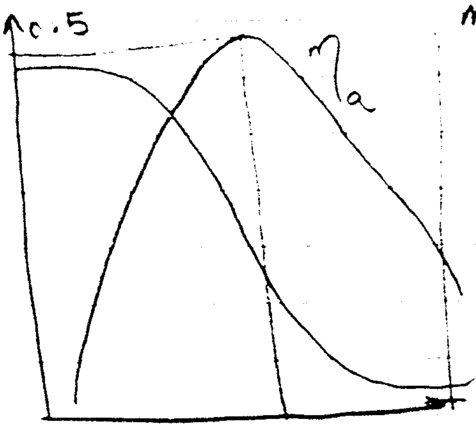
$$\eta_a = \frac{E_g \int_{E_g}^{\infty} N_E \, dE}{\int_{0}^{\infty} E N_E \, dE}$$

→ Maximum theoritical efficiency.



E_g → Energy gab.
N_E → no of e's exist in
dE →

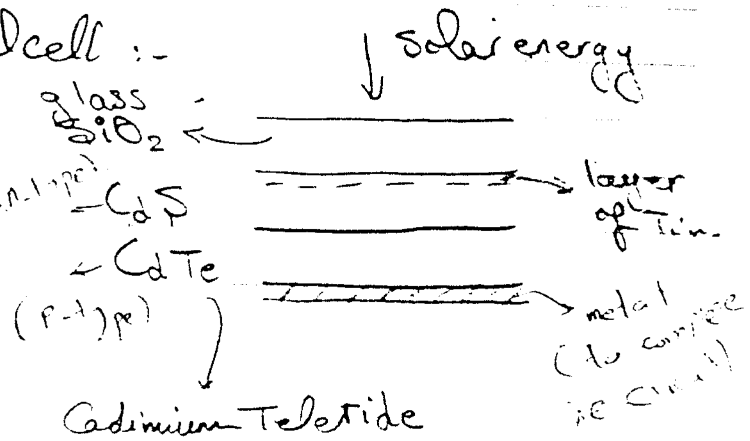
Efficiency of semiconductor depend on Eg energy gab. the ~~optimum~~ maximum efficieny = 0.5 which is obtained at the ~~op~~ optimium Eg = 1.1 eV That's why Silicon is most preferred because it has Eg 1.1eV.



Note:-
P-type → Boron doped.
N-type → phosphourus doped.

→ The Fixed Cost of establishing of power plant of solar energy = 40 - 100 the cost of the Convential method for power plant.

→ Practical example of Fuelcell :-
* Layer of tin is Required to give electrical conductivity for the glass.



Main problem of solar energy is to have semiconductor with $E_g \sim 1.1$ eV & its eff. is near to the max theoritical ~~energy~~ efficiency & in the same time to have low Fixed cost to be used for & industrial scale.

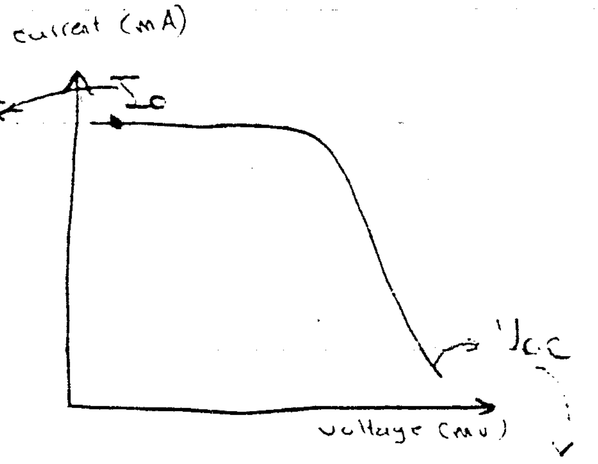
The actual efficiency is lower than 0.5 because:-
→ Not all the photons that have energy > Eg are absorbed by the Semi-silicon so we need to multp. the intg. by α_a → absorption coefficient.

$$\eta_{\alpha} = E_g \int_0 \alpha_a$$

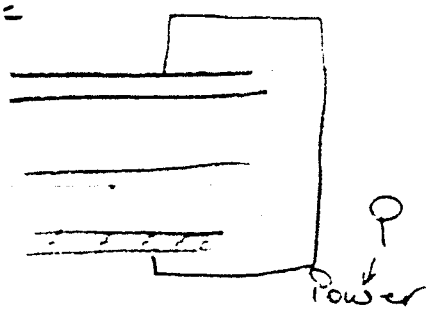
→ The Radiation intensity is variable not Fixed with time, besides it also Change from one place to another place. e.g Rad. intensity in Egypt = 300 w/m^2, and at the top pole = 100 w/m^2.

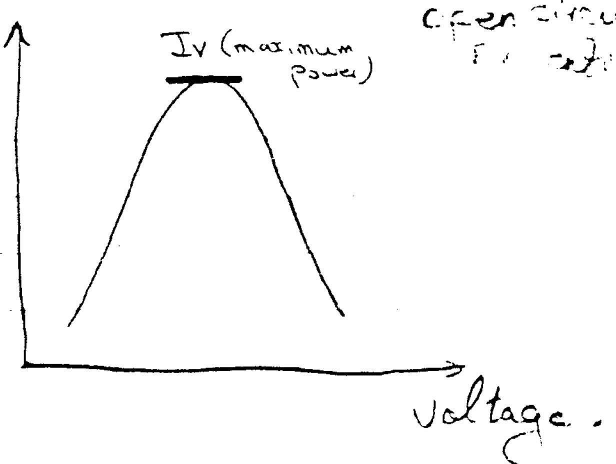
~~Stage efficiency~~ :- *Calculating efficiency

* By experiments at Radiation intensity ~~1000~~ $1000\ W/m^2$ and $T = 300°K$ (Standard conditions)

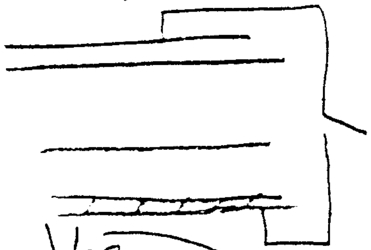


Ic is obtained from = short circuit.





Voc is voltage in case of ~~of~~ open circuit.



$$\eta_V = \frac{V_{oc}}{E_g}$$

V_{oc} → open circuit

E_g → Energy gab.

→ Voltage efficiency.

Current efficiency (→ Collection) :-

$$\eta_{col} = \frac{I_{sc}\ (\text{short circuit current})}{\text{flux of absorbed photons}}$$

This represents the amount of electrons re-combined with the holes in the p-n junction

3. Fill Factor $= \frac{(I * V) \text{ at max power}}{V_{oc} * I_o} = \eta_F$

Overall efficiency:-

$$\eta \leq \eta_a \, \eta_v \, \eta_{ioc} \, \eta_F$$

↳ the inequality ~~of~~ represent
1) that some photons are absorped & some are ~~ef~~ emmitted & other transition
2) There's resistance to electric current within the cell itself (between metal and p-junction, between p-junction and n-junction, bet n-junction and transparent part)

* MIS (Metal-insulator-semiconductor) can be used instead of (p-n junction)

Note:-

→ Main disadv. of photovoltaic cells that they are intermittent where it depend on presence of solar energy which is not permenenant along the day, ~~so~~ & the solar energy is not storable so we need to convert it inside in other form inside Battary.

* To calculate the area of the ~~XXXX~~ solar cell

If the cars $Hp = 75\ Hp$, solar ~~cell~~ energy reaching Egypt $= 300 \frac{W}{m^2}$

$\eta = 10\ \%$

$$\text{Area} = \frac{75\,Hp \times 746\,\frac{watt}{1\,Hp}}{0.1 \times 300\,\frac{watt}{m^2}} = \checkmark\ m^2$$

The cars operating on solar energy stores some of this energy in a battery so as to be used at night. So, the above example is the measurment of the area of solar cell